Fractal models for event-based and dynamic timers

Delignières, D*, Lemoine, L. & Torre, K.
EA 2991 Motor Efficiency and Deficiency
University Montpellier I, France

We recently showed that two kinds of timing control could be distinguished, namely event-based and dynamical timers, used in discrete (finger tapping) and continuous (wrist oscillation) tasks, respectively (Delignières, Lemoine & Torre, 2004). We showed that these two timers present distinct spectral signatures, contrasted by opposite behaviors in high frequencies. We also evidenced that these timers produce interval series possessing fractal properties.

We present in this communication two models that produce time interval series presenting the statistical properties previously evidenced in discrete and continuous rhythmic tasks. The first one is an adaptation of the classical Wing and Kristofferson (1973) internal clock model, allowing to simulate the series obtained in continuation tapping. The second is derived from the 'hopping model' proposed by West and Scafetta (2003) and allows simulating series obtained in unimanual oscillations. We show, using ARFIMA modeling, that these simulated series possess fractal properties. In both cases, fractal fluctuations arise from the combination of an auto-regressive process and a random walk, suggesting a possible universal source for $1/f$ noise in natural systems. Finally, we present coupled versions of these models, allowing to predict the nature of serial correlations in bimanual tapping and bimanual oscillation tasks.

Delignières, D., Lemoine, L. & Torre, K. (2004) Time intervals production in tapping and oscillatory motion. *Human Movement Science, 23*, 87-103.

West, B.J. & Scafetta, N. (2003). Nonlinear dynamical model of human gait. Physical Review E, 67, 051917.

Wing, A.L. & Kristofferson, A.B. (1973). The timing of interresponse intervals. Perception and Psychophysics, 13, 455-460.